Environmentally Preferable Paints Minimize Harm, Maximize Savings

An Aberdeen Proving Ground Study

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Executive Summary

Aberdeen Proving Ground (APG), in a recent study of 565 architectural and anticorrosive latex paints used on the post, identified 71 that cause the least harm to the environment and cost an average $1.76 per gallon less than nonpreferable paints. The recommended paints include flat, semi-gloss, and gloss finishes for interior and exterior architectural latex paints from 13 manufacturers. By restricting purchases to environmentally preferable paints, APG will minimize its environmental impact while saving money and meeting its mission requirements.

The study was limited to architectural and anti-corrosive paints, the paint categories most commonly used at APG. Paints were evaluated on the basis of standards set for the content of heavy metals and dangerous chemicals as well as for levels of volatile organic compounds.

The study began with a list of more than 2,200 paints to be reviewed against comprehensive environmental standards set by Green Seal and adopted by APG as well as APG's environmental standards for chemical content. Green Seal is a nonprofit organization that sets environmental standards for manufactured products and certifies products that meet them.

Robert Solyan, who managed the study, gratefully acknowledges the participation of William Newton at Maryland Environmental Technology Demonstration Center - Aberdeen Test Center; Elizabeth Longenecker of the APG Pollution Prevention Office; Joseph LoCasale and Sheila Jones, both with Dynamac, which coordinated the study; Michael Shor, Arthur B. Weissman, Margaret E. Blanchard, and Mark T. Petruzzi, all with Green Seal; and the Armed Forces Radiobiology Research Institute for editing, publishing, and graphics services, including Carolyn Wooden, Guy Bateman, and Mark Behme.

Objective

This study was conducted to develop guidance for the purchase of environmentally preferable paints in order to significantly reduce potential environmental damage from the use and disposal of paints at Aberdeen Proving Ground (APG).

Methods

APG, through a contract with Green Seal, reviewed all material safety data sheets (MSDSs) for architectural and anticorrosive paints stocked at APG. The paints were evaluated against established APG paint standards.

Manufacturers were contacted as needed for additional information and to determine and review analogs if pertinent data were not available. To confirm the manufacturer-stated levels of volatile organic compounds, paints were tested by a federal lab, using the Environmental Protection Agency Reference Test Method 24 (EPA, 1997).

The test results were reviewed and a list of recommended paints was developed.

Procedures

The study began with a list of more than 2,200 paints in inventory at Aberdeen Proving Ground (APG). Preferable paints were identified as those that passed each step in a series of evaluations.

Step 1: Manufacturer paint codes and names were reviewed for duplication and were reviewed against APG standards for architectural paint and anti-corrosive paint.

Step 2: Each paint's material safety data sheet (MSDS) was reviewed against the standards for prohibited harmful ingredients.

Step 3: Paint manufacturers' information on volatile organic compounds (VOCs) was reviewed to identify those within the limits of the standards.

Step 4: White base paint samples were tested at the Maryland Environmental Technology Demonstration Center - Aberdeen Test Center (METDC-ATC) to verify manufacturers' VOC data.

Standard-Setting Process for Paints

APG paint standards were developed from those established by Green Seal in 1990 through an open and collaborative process for setting environmental standards for product categories. The process maximizes public input by involving industry, academia, government, the public, environmental organizations, and product users. Standards are designed to identify products that have the least impact on the environment and to ensure that, on the date of publication of a product category standard, 15% to 20% of the market can meet the standard.

Each standard is based on the life cycle of the category and includes relevant information on material extraction, product packaging, distribution, use, recycling and disposal. The initial standard is submitted to the public for comment, after which a formal review of the comments is published and the standard is finalized. An appeals process is available. Each standard is reviewed and updated when the relevant technology changes.

Prohibited Inorganic Ingredients

Historically, several toxic metals have served as preservatives, additives and pigments in paints. While most architectural paints today do not contain these highly dangerous compounds, some still contain small amounts. APG standards prohibit the five metallic compounds in table 1 because of their especially severe effects on the human body.

Table 1. Prohibited inorganic compounds.

Antimony
Cadmium
Hexavalent chromium
Lead
Mercury

Lead, for example, is probably the most familiar prohibited ingredient because of its highly publicized effects (ATSDR, 1993). Unfortunately, thousands of children and adults have served as case studies for lead poisoning due to exposure from either paint or lead plumbing fixtures. While the effects can be severe in humans of any age, children suffer the harshest effects. Long-term exposure stunts growth and causes stomach and gastrointestinal ailments as well as long-term debilitation of the central nervous and neurological systems.

Another metal with similar effects is mercury (ATSDR, 1997a). This dangerous compound attacks the central nervous system while wreaking havoc on the brain, causing tremors, hearing and vision loss, nausea, vomiting, and dermal irritation.

Prohibited Organic Ingredients

Organic ingredients in paints serve various purposes including antifreeze. Some of the compounds pose a significant danger to both environmental and human health. The 20 ingredients in table 2 were deemed dangerous enough to be prohibited altogether.

Paints that were eliminated due to the presence of harmful ingredients contained one or more of the prohibited compounds. The following discussion outlines harmful effects some of the compounds can have on humans and the environment.

Formaldehyde (ATSDR, 1997b) is used in paint as a preservative although it serves other purposes in many industries. The most common exposure to formaldehyde is from contaminated air. Urban

Table 2. Prohibited organic compounds.

Methylene chloride	Di-n-butyl phthalate
1,1,1-Trichloroethane	Di-n-octyl phthalate
Benzene	Diethyl phthalate
Toluene (methylbenzene)	Dimethyl phthalate
Ethylbenzene	Isophorone
Vinyl chloride	Formaldehyde
Naphthalene	Methyl ethyl ketone
1,2-Dichlorobenzene	Methyl isobutyl ketone
Di (2-ethylhexyl) phthalate	Acrolein
Butyl benzyl phthalate	Acrylonitrile

residents are at comparatively increased risk, and individuals with asthma have been found to be somewhat more sensitive than others to formaldehyde. Minor effects include irritation of the ear, nose, and throat tissues. The Environmental Protection Agency and the International Agency for Research on Cancer classify formaldehyde as a probable human carcinogen. The National Toxicology Program classifies formaldehyde gas as reasonably anticipated to be a carcinogen.

Ethylbenzene (ATSDR, 1997c) is also associated with greater risk for urban residents or those near highly industrialized areas. Low-level exposures irritate the throat and eyes; higher levels produce symptoms such as dizziness and decreased movement. Short-term, high-level exposures cause kidney and liver damage as well as blood and nervous system abnormalities.

Benzene (ATSDR, 1995a) is classified as a carcinogenic substance. It enters the air through gasoline production and burning as well as off-gassing from products such as paints. It has an increased photochemical reaction in the presence of common air pollutants such as nitrogen oxides and sulfur dioxide, possibly contributing to decreased air quality in urban areas.

Toluene (ATSDR, 1998) severely effects the brain, causing headaches, confusion, and memory loss as well as tiredness, nausea, and weakness after exposure. Extremely high-level exposure can cause dizziness, unconsciousness, loss of muscle control, or even death. While it does effect the kidneys, the liver, and the central nervous system, there is inconclusive evidence that the damage is permanent. The Environmental Protection Agency designates toluene a priority pollutant.

Methyl ethyl ketone (OPPT, 1994) causes severe damage to the kidneys, liver, and blood, depending on the level or length of exposure. It also causes central nervous system depression as well as mild pulmonary and neurological problems. The compound rapidly reacts photochemically and is a precursor to the photochemical smog associated with urban areas.

Naphthalene (ATSDR, 1995b) is an aromatic compound that can damage or destroy the red blood cells in the human body, causing hemolytic anemia, a disease associated with fatigue, restlessness, and lack of appetite. If pregnant, a woman can pass the anemia to her unborn child via shared blood. While the compound has not yet been classified as a human carcinogen there is some evidence to suggest carcinogenicity in female mice (NIEHS, 1998).

Di-2-ethylhexyl-phthalate (DEHP; ATSDR, 1989) is considered slightly to moderately toxic because it depresses the central nervous system. It can also cause dermal, respiratory, gastrointestinal, and esophageal irritation. One study (Singhe, 1972) also showed fetotoxicity, teratogenicity, and decreased fertility in mice. Another study (Thiess et al., 1978) of workers exposed to DEHP for greater than 15 years showed an increased rate of urethral and bladder papillomas when compared to the relatively unexposed population.

Di-n-butyl phthalate (DBP; ATSDR, 1990) is considered toxic by all routes (dermal, ingestion, and inhalation) as illustrated by its many health effects on the human body. Contact burns on the skin and eyes as well as dermatitis, nausea, and dizziness are some of the minor effects. More serious symptoms of exposure in test animals (TOXNET, 1999) are photophobia, polyneuritis, edema, keratitis, nephritis, testicular atrophy, miscarriages, and menstrual disorders. DBP reacts photochemically in the atmosphere and degrades to hydroxyl radicals.

Volatile Organic Compounds

Volatile organic compounds (VOCs) are organic compounds with a vapor pressure greater than 0.1 millimeter of mercury at 25 °C as determined by American Society for Testing and Materials (ASTM) D3960, Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings. Excluded from this definition are methane, carbon monoxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate. VOCs are associated with drying paint, producing the typical paint odor. A general rule is the higher the VOC level, the more pungent the odor.

All oil and many latex-based paints contain organic solvents to disperse and bind other paint components. These organic solvents are the major ingredients that contribute to VOC levels in paints. Paints that are specifically marketed as “fast drying” contain even higher levels of these organic solvents.

One of the significant findings (ALA, 1999) associated with VOCs is the formation of ground-level ozone and photochemical smog. Primary and secondary health effects associated with ground-level ozone range from temporary shortness of breath, asthma, and lung irritation to chronic diseases such as pulmonary fibrosis. As these two environmental factors become more commonplace across the country, more government agencies are acting to limit the VOC levels in common products such as architectural paint. These severe concerns

Table 3: Permitted VOC levels for architectural and anti-corrosive paints.

Type of Paint	VOCs (g/L)	VOCs (lbs/gal)
Interior Architectural		
Flat	50	0.42
Non-flat	150	1.25
Exterior Architectural		
Flat	100	0.83
Non-flat	200	1.66
Anti-Corrosive		
Flat	250	2.10
Semi-gloss	250	2.10
Gloss	250	2.10

prompted the strict standards for architectural coatings that appear in table 3.

Findings

This study, as shown in table 4, reviewed more than 2,200 paint codes/names and found 281 duplicates. Of the resulting 1,919 paints reviewed against APG standards for architectural and anti-corrosive paints, 565 met the requirements. Manufacturers provided MSDSs on 469 of the 565 paints; MSDSs were not made available on 96 paints. A review of the MSDSs for the 469 paints found that 399 contained no prohibited organic compounds; 70 paints were eliminated based on

Table 4. Paint study statistics.

Factors	No. of paints evaluated	No. of paints eliminated
Review of codes/names	~ 2,200	281
Review against APG standards	1,919	1,354
MSDSs requested	565	96
Review of stated ingredients	469	70
Evaluation of VOC levels	399	281
Samples requested	118	11
Testing for VOC levels	107	36
Recommended	71	

harmful ingredients. Of the remaining 399 paints, 118 met the standards for volatile organic compound (VOC) levels as stated by the manufacturers; 281 paints exceeded the VOC standards. Of the remaining 118 paints, samples of 11 were no longer available.

The remaining 107 paints, which met APG standards for ingredients as well as VOC levels, based on MSDS information, were delivered to the Maryland Environmental Technology Demonstration Center - Aberdeen Test Center for VOC testing by the Environmental Protection Agency Reference Test Method 24. Seventy-one paints (see appendix), or 66% of those tested, passed the VOC test.

Altogether, 13% of the 565 paints reviewed were found to be environmentally preferable. As table 5 shows, the paints include interior and exterior coatings in flat, semi-gloss, and gloss finishes. No anti-corrosive paints met the standards.

Paint prices were obtained for both recommended and non-recommended paints from the three most frequent suppliers. The environmentally preferable paints cost less than the non-recommended paints for each supplier, with the average for all three being $1.76 a gallon less.

Overall, this evaluation of environmentally preferable paints provides an assortment of paints in a variety of finishes. The paints are available from 13 manufacturers, providing depth for competitive procurement. Since environmentally preferable paints that meet Aberdeen Proving Ground (APG) needs are available, the post can restrict its purchases to these products. It seems likely that doing so will save money and that selecting from the recommended paints will enable APG to lessen its environmental impact and carry out its mandates.

In addition to identifying the 71 environmentally preferable paints, APG has taken the following initiatives to promote their use.

- Use of the paint standards described in this study as the basis for ordering architectural paints. This will validate the environmental preferability of paints used at APG. It will obviate the need to gather and evaluate data on each paint before purchase.

Table 5. Environmentally responsible paints in each finish.

	Interior	Exterior	Total
Flat	10	6	16
Semi-Gloss	34	15	49
Gloss	1	5	6

- Circulation of the APG paint standards to all units and tenants, with the request that buyers adhere to the standards. This request is coupled with reminders of proper paint disposal measures.

- Coordination with nearby paint suppliers, requesting that they voluntarily provide only those paints that meet APG standards or that they suggest the use of alternate paints that do meet the standards. In return, APG is able to cooperating suppliers' sales of paint by promoting "just-in-time" delivery from them. This will reduce paint stockpiles on post and lessen the likelihood of improper disposal.

- Circulation of the APG paint standards to manufacturers, with an invitation to them to submit additional paints they feel meet the standards. This will increase the number of recommended paints.

- Addition of the compliance line "Must meet APG environmental standards for paints." to purchase orders for paints and painting contracts. A similar compliance line is required on invoices so that suppliers certify "Paints meet APG environmental standards for paints." APG informs contractors that invoices not carrying this declaration may not be paid.

- Publication of APG efforts to promote environmentally preferable paints to include all activities from purchasing through disposal. This increases acceptance of the standards on and off the post and wins recognition for APG's leadership.

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Appendix

Appendix

Environmentally Preferable Paints

(displayed alphabetically by manufacturer within finish)

APG ID number	Manufacturer	Product name	Reported VOC level (g/L)	Tested VOC level (g/L)
		Interior Flat, VOC Limit = 50 g/L		
60221	Benjamin Moore	Pristine Flat	26	12
62136	Benjamin Moore	Moore's Ceiling White Flat	37	51
51488	Coronado Paint	Super Kote 1000 Vinyl Ltx. Flat	30	50
60269	Duron	Texture Paint Flat	47	49
79891	Duron	Builder's Masterpiece Int. Vinyl Ltx. Flat	15	47
71830	Dutch Boy	Fashion Fresh Int. Ltx. Flat	56	28
54984	Kurfee's Coatings – Servistar	Supreme Int. Odor Free Ltx. Primer-Sealer	128	47
57582	PPG Industries	8 Year Int. Wall Deep Base	48	20
	Sherwin Williams	Style Perfect Flat	37	51
60267	United Coatings	Int. Ltx. Texture Paint Sand	17	5
		Interior Semi-Gloss, VOC Limit = 150 g/L		
60226	Benjamin Moore	Pristine Interior Ltx. SG	18	19
60220	Benjamin Moore	Pristine Interior Ltx. Eggshell	28	57
60210	Benjamin Moore	K&B Acrylic Ltx. Satin Finish	71	45
60220	Benjamin Moore	Pristine EGG	23	16
61940	Benjamin Moore	Pristine SG	18	20
60226	Benjamin Moore	Pristine SG		
60206	Benjamin Moore	Pristine SG		
35375	Benjamin Moore	Regal Satin	50	68
60210	Benjamin Moore	Moore Kitchen & Bath Satin	74	81
74160	Benjamin Moore	Moorcraft Super Hide Ltx. SG Enamel	136	116
51017	Bruning Paint	Pacon Supreme Ltx. Semi-Lustre Mid-tone Base	123	111
74807	Bruning Paint	Pacon Supreme Ltx. Semi-Lustre Enamel	122	144
51811	Duron	Plastic Kote Int. Acrylic SG	144	123
60270	Duron	Pro Kote Int. Acrylic SG	137	112
32892	Duron	Ultra Deluxe Int. Acrylic Ltx. SG Enamel	116	96
60363	Dutch Boy	Fresh Look Int. Ltx. SG Enamel	95	119
34548	Glidden Paint	3400 Spred Satin Ltx. Wall Paint	116	107
53421	Lasting Paints	Acrylic Ltx. Tint Base Eggshell	138	105

APG ID number	Manufacturer	Product name	Reported VOC level (g/L)	Tested VOC level (g/L)
53420	Lasting Paints	Acrylic Ltx. Pastel Base Eggshell Base	138	120
53404	Lasting Paints	Ltx. SG Pastel Base	114	62
72828	PPG Industries	Lucite Int. Ltx. SG Natura	105	81
54968	Sears	Easy Living SG Wall & Trim	107	111
61129	Sherwin Williams	Super Paint Int. SG	184	142
61114	Sherwin Williams	ProMar SG	62	81
61129	Sherwin Williams	Classic 99 Int. SG	121	35
72519	Sherwin Williams	ProMar 700 SG	62	52
37644.01	Sherwin Williams	Style Perfect SG	103	76
60398.31	Sherwin Williams	ProMar 200 SG	142	86
60398	Sherwin Williams	ProMar 400 SG	103	99
37645.01	Sherwin Williams	Style Perfect	119	125
60398	Sherwin Williams	ProMar 200 Int. Ltx. SG	141	44
60398	Sherwin Williams	ProMar 400 Int. Ltx. SG	103	97
15387	Sherwin Williams	StylePerfect Int. Ltx. SG	145	120
37645	Sherwin Williams	StylePerfect Int. Satin	123	90
60398	Sherwin Williams	ProMar 200 Int. Ltx. Eg-Shel	146	137
61129	Sherwin Williams	Classic 99 Int. Satin Ltx.	166	144
		Interior Gloss, VOC Limit = 150 g/L		
57382	Duron	Deluxe Gloss	126	117
		Exterior Flat, VOC Limit = 100 g/L		
59525	Benjamin Moore	Moore's Latex Exterior	51	44
59528	Benjamin Moore	Moorcraft Super Spec Premium Ltx. Ext. Flat	32	54
59528	Benjamin Moore	Moorcraft Flat	35	80
74215	Benjamin Moore	Fresh Start Ext. Primer	31	92
59512	Benjamin Moore	Moorcraft Super Spec Premium Ltx. Ext. House & Trim	250	67
61776	United Paint Mfg.	Ext. Ltx. House Paint	90	18
		Exterior Semi-Gloss, VOC Limit = 200 g/L		
59512	Benjamin Moore	Moorcraft Satin	214	111
73404	Benjamin Moore	Moore Exterior Floor and Patio	155	176
50884	Benjamin Moore	Moorglo House and Trim Exterior Non-Flat	210	191
67690	Coronado	Super Kote 3000 Ltx. SG 74	60	88
51497	Coronado	Acrylic House Paint 12 SG	131	169
71954	Duron	Weathershield SG	173	203

APG ID number	Manufacturer	Product name	Reported VOC level (g/L)	Tested VOC level (g/L)
51858	Duron	Weathershield Ext. 100% Acrylic Ltx. Satin	138	119
74175	Duron	Ultra Deluxe Exterior 100% Acrylic Ltx. SG	167	139
51861	Duron	Weathershield Ext. Acrylic SG	152	145
55143	Sherwin Williams	Super Paint Ext. Satin Ltx.	108	104
55143.12	Sherwin Williams	Super Paint Latex Satin	108	129
15633.24	Sherwin Williams	A-100 Exterior Satin	133	158
15633	Sherwin Williams	Exterior Satin Ltx.	133	52
67226	Sherwin Williams	Weather Perfect Ext. Satin Ltx.	111	82
59306	United Coatings	Walmart 15 Year SG Accent Base	176	150
		Exterior Gloss, VOC Limit = 200 g/L		
68076	Dutch Boy	Performer Ext. Ltx. Gloss	135	96
55143	Sherwin Williams	Super Paint Ext. Gloss Ltx.	155	80
15633.37	Sherwin Williams	A-100 Gloss	155	107
15633	Sherwin Williams	A-100 Ext. Gloss Ltx.	154	64
65899	United Coatings	Walmart Accent Base Ext. Gloss House & Trim	149	81